PLANT ITEM MATERIAL SELECTION DATA SHEET

ISSUED BY
RPP-WTP PDC

R10591497

UFP-VSL-00062-A/B/C (PTF)

Ultrafilter Permeate Collection Vessel

- Design Temperature (°F)(max/min): 120/40
- Design Pressure (psig) (max/min): 15/-10.29
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

Offspring items

UFP-VSL-00023 – 00025, UFP-VSL-00032 – 00037
UFP-VSL-00072 – 00073, UFP-VSL-00082 – 00084
UFP-VSL-00051, UFP-VSL-00069 -- 00070, UFP-VSL-00075
UFP-PJM-00018 – 00022, UFP-PJM-00039 – 00043
UFP-PJM-00051 – 00052, UFP-PJM-00076 – 00078
UFP-PJM-00070, UFP-PJM-00073, UFP-PJM-00107
UFP-RFD-00027 – 00028, UFP-RFD-00030 – 00034
UFP-RFD-00037 – 00039, UFP-RFD-00042 – 00049

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on sheets 5 and 6

No maintenance will be performed.

Operating Modes Considered:

- Normal operating conditions are considered.
- The vessel may be cleaned using 2 N HNO_3 with residual chlorides and fluorides at normal operating temperatures; the condition of high temperature and acid is not examined.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water

STEVEN WAKEMAN VAIL
STATE OF WASHINGTON
39250
REGISTERED
PROFESSIONAL ENGINEER
11/17/05
EXPIRES: 12/07/07

Please note that source, special nuclear and byproduct materials, as defined in the Atomic Energy Act of 1954 (AEA), are regulated at the U.S. Department of Energy (DOE) facilities exclusively by DOE acting pursuant to its AEA authority. DOE asserts, that pursuant to the AEA, it has sole and exclusive responsibility and authority to regulate source, special nuclear, and byproduct materials at DOE-owned nuclear facilities. Information contained herein on radionuclides is provided for process description purposes only.

This bound document contains a total of 6 sheets.

2	11/17/05	Issued for Permitting Use	[signature]	[signature]	[signature]
1	1/23/05	Issued for Permitting Use	DLA	JRD	SWV
0	10/15/04	Issued for Permitting Use	DLA	JRD	SWV
REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	APPROVER

PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

Permeate collected in these vessels is sampled and then routed to the CXP system for further treatment. Permeate collected from solids washing is routed to PWD-VSL-00015 or PWD-VSL-000016.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series stainless steels are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Divine's work (1986) with simulated-radwaste evaporators, six months at 140°F, showed 304L was slightly more resistant to corrosion (<0.2 mpy) than was 316L (<0.6 mpy); Ni 200, pure nickel, was much less resistant (≈7 mpy) probably due to the complexants. Zapp (1998) notes that the Savannah River evaporator vessels, operating at about 300°F, are made of 304L and have suffered no failures in about 30 years; 304L heat transfer surfaces have failed however after about 10 years. Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling, >212°F.

Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks (1996) states the corrosion rate data beyond about 122°F are too low. Uhlig (1948) has shown that pure nickel is resistant to corrosion by NaOH. However, as Divine (1986) pointed out, the presence of complexing agents may reverse the trend. Agarwal (2000) states that the higher nickel alloys are highly corrosion resistant though specific mention of alkaline media is not made. The general literature mainly discusses cracking problems (see below) rather than uniform corrosion.

The amount of dilution of fluoride during possible acid wash is unknown. Wilding and Paige (1976) have shown that in 5% nitric acid with 1000 ppm fluoride at 290°F, the corrosion rate of 304L can be kept as low as 5 mpy by the use of Al^{+++}. Additionally, Sedriks (1996) has noted with 10% (≈2N) nitric acid and 3,000 ppm fluoride at 158°F, the corrosion rate of 304L is over 4,000 mpy. Therefore, there is a concern about excessive corrosion rates during acid cleaning or should acid be from the Ultrafiltration Feed Vessels. Acid wash should only be performed at normal operating temperatures in order to reduce the extent of attack by chloride (pitting and crevice corrosion) and general corrosion due to fluoride. Properly protected by temperature and fluoride complexants such as Al^{+++}, 304L may be suitable. The more resistant 316L is recommended together with thorough flushing before acid is added.

Conclusion: At temperatures less than about 140°F, 304L is expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy. During acid cleaning, in the presence of fluoride, a more resistant alloy may have to be considered unless steps are taken to reduce the effect of the fluoride. Assuming a limited time of exposure to acid and thorough washing, 0.04 inch corrosion allowance is recommended.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media. Further, Revie (2000) and Uhlig (1948) note nitrate inhibits chloride pitting.

Normally the vessel is to operate at 86°F. At the normal temperature, based on the work of Zapp (1998) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions. Under acidic or neutral pH conditions, 316L will be more resistant to pitting due to the chloride concentration.

If the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the source of the water, being shorter for filtered river water and longer for DIW. Pitting has been observed in both cases, though much less frequently in DIW. Therefore, controls on washing and rinsing are required.

Conclusion: Localized corrosion, such as pitting, is common but can be mitigated by alloys with higher nickel and molybdenum contents. Based on the expected operating conditions, 304L is expected to be satisfactory. Due to the possibility of acid washes inside the vessels, 316L stainless steel is the minimum recommended.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion: Possible, but not believed likely in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F but this will depend on conditions. Berhardsson et al (1981) suggest that if the chloride concentration is < 50 ppm, temperatures up to 260 are acceptable whereas temperatures should be less than about 75°F if the chloride concentration approaches 1% (10,000 ppm). At the stated temperature and alkaline conditions, either 304L or 316L is expected to be satisfactory.

Conclusion: Because of the normal operating environment as well as that which can occur during off normal conditions, the minimum alloy recommended is a 304L stainless steel.

PLANT ITEM MATERIAL SELECTION DATA SHEET

e Crevice Corrosion
See Pitting.

Conclusion: See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion: Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth – the temperature is approximately correct but the pH is either too alkaline or too acid. Further, the system is downstream of the main entry points of microbes.

Conclusion: MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Under the stated operating conditions, corrosion fatigue is a not expected to be a problem in a properly designed vessel.

Conclusions*:* Not considered to be a concern.

i Vapor Phase Corrosion
Not expected to be a concern.

Conclusion: Not a concern.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.004 inch is adequate for components with solids content less than 2 wt%. Because of the negligible concentration of undissolved solids, no localized protection is necessary for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s for a usage of 100 % operation as documented in 24590-WTP-M0C-50-00004.

The PJM nozzle requires no additional protection as documented in 24590-WTP-M0C-50-00004.

Conclusion: The recommended corrosion allowance provides sufficient protection for erosion of the vessel.

k Galling of Moving Surfaces
There are no moving surfaces within the vessels.

Conclusion: Not applicable.

l Fretting/Wear
No contacting surfaces are expected.

Conclusion: Not considered a problem.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion: Not applicable.

n Cavitation
None expected.

Conclusion: Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion: Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion: The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-M0C-50-00004, Rev. D, *Wear Allowance for WTP Waste Slurry Systems*
2. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
3. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
4. CCN 130172, Divine, JR, 1986, Letter to A.J. Diliberto, *Reports of Experimentation*, Battelle, Pacific Northwest Laboratories, Richland, WA 99352
5. CCN 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
6. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
7. Berhardsson, S, R Mellstrom, and J Oredsson, 1981, *Properties of Two Highly corrosion Resistant Duplex Stainless Steels*, Paper 124, presented at Corrosion 81, NACE International, Houston, TX 77218
8. Danielson, MJ & SG Pitman, 2000, *Corrosion Tests of 316L and Hastelloy C-22 in Simulated Tank Waste Solutions*, PNWD-3015 (BNFL-RPT-019, Rev 0), Pacific Northwest Laboratory, Richland WA.
9. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
10. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
11. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
12. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
13. Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
14. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
15. Smith, H. D. and M. R. Elmore, 1992, *Corrosion Studies of Carbon Steel under Impinging Jets of Simulated Slurries of Neutralized Current Acid Waste (NCAW) and Neutralized Cladding Removal Waste (NCRW)*, PNL-7816, Pacific Northwest Laboratory, Richland, Washington.
16. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
17. Zapp, PE, 1998, *Preliminary assessment of Evaporator Materials of Construction*, BNF—003-98-0029, Rev 0, Westinghouse Savannah River Co., Inc for BNFL Inc.

Bibliography:

1. CCN 130170, Blackburn, LD to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Evaluation of 240-AR Chloride Limit*, August 15, 1991.
2. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
3. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
4. Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218.
5. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Ultrafilter permeate collection vessel (UFP-VSL-00062A/B/C)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.15E+01	3.17E+01			
Chloride	g/l	1.21E+01	1.45E+01			
Fluoride	g/l	1.44E+01	1.73E+01			
Iron	g/l	2.31E+00	2.60E+00			
Nitrate	g/l	2.23E+02	2.59E+02			
Nitrite	g/l	6.69E+01	8.01E+01			
Phosphate	g/l	4.83E+01	5.66E+01			
Sulfate	g/l	2.57E+01	3.08E+01			
Mercury	g/l	7.47E-02	1.94E-02			
Carbonate	g/l	9.03E+01	9.93E+01			
Undissolved solids	wt%					
Other ($NaMnO_4$, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-UFP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: UFP17, UFP33
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: 24590-PTF-M6-UFP-P0004, Rev 1
PFD: 24590-PTF-M5-V17T-P0011, Rev 0
Technical Reports: N/A

Notes:

1. Concentrations less than 1×10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. T normal operation 77 °F to max 86 °F (24590-PTF-MVC-UFP-00003, Rev 0)
3. Alkaline pH approximately 12 to 14

Assumptions:

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

4.14.4 Ultrafilter Permeate Collection Vessel (UFP-VSL-00062 A/B/C)

Routine Operations

Permeate collected in the ultrafilter permeate vessels (UFP-VSL-00062A/B/C) is sampled and then routed to the cesium ion exchange process system (CXP) for further treatment. The permeate collected from solids washing is routed to the acidic/alkaline effluent vessels (PWD-VSL-00015/00016). If necessary, the permeate routed to the CXP system may be diluted with process condensate prior to transferring to meet the 5 M sodium design basis requirement (SpG ~1.25).

Non-Routine Operations that Could Affect Corrosion/Erosion

Off-specification permeate (excessive turbidity) can be routed back to either of the ultrafilter feed preparation vessels (UFP-VSL-00001A/B).